European Environment Agency
European Topic Centre on
Biological Diversity

Technical paper N° 11/2015

Short topic assessment on Biodiversity:

Migration corridors

Green infrastructure

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February 2015

The European Topic Centre on Biological Diversity (ETC/BD) is a consortium of twelve organisations
under a Framework Partnership Agreement with the European Environment Agency for the period 2014-2018
ALTERRA AOPK-CR ECNC Ecologic ILE-SAS ISPRA JNCC MNHN SC-NAT SLU Space4environment UBA

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Context:

The Topic Centre has prepared this Technical paper in collaboration with the European Environment Agency (EEA) under its 2014 work programme as a contribution to the EEA's work on Biodiversity and ecosystem assessments and networks – contributing to European and global processes.

Citation:

Please cite this report as
Civic, K. & Delbaere, B., 2014. Short topic assessment on Biodiversity: Migration corridors Green Infrastructure. ETC/BD report to the EEA.

Disclaimer:

ETC/BD Technical paper N° 11/2015
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1 Policy context

Ecological connectivity has been a priority for international biodiversity conservation policy since a few decades. More recently this was confirmed by Target 11 of the Aichi Biodiversity Targets, agreed at the 10th Conference of the Parties of the Convention on Biological Diversity (CBD) in 2010. This states that 'By 2020, at least 17 % of terrestrial and inland water areas and 10 % of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, are conserved through effectively and equitably managed, ecologically representative and well-connected systems of protected areas and other effective area-based conservation measures, and integrated into the wider landscape and seascape' (CBD, 2010).

One of the important tools for achieving ecological connectivity is migration corridors. These are essentially measures to maintain or restore a degree of coherence in fragmented ecosystems.

The overarching European Union (EU) policy 'Europe 2020 - A strategy for smart, sustainable and inclusive growth' (EC, 2010a) aims to achieve its priorities by:

- developing an economy based on knowledge and innovation;
- promoting sustainable growth through greater resource efficiency, greener and more competitive economies; and
- fostering high-employment economies for improved social and territorial cohesion.

Recognizing the importance of halting biodiversity loss, and framed by the Europe 2020 strategy, the EU adopted the ´European Biodiversity Strategy to 2020 - Our life insurance, our natural capital´ in 2011 to address the pressing issue of biodiversity loss (EC, 2011a). The strategy is built around six mutually supportive targets which address the main drivers of biodiversity loss. Target 2 aims to ensure that 'by 2020, ecosystems and their services are maintained and enhanced by establishing Green Infrastructure (GI) and restoring at least 15 % of degraded ecosystems'.

The European Commission released in May 2013 its Communication 'Green Infrastructure (GI) – Enhancing Europe's Natural Capital' (EC, 2013c) (implementing Action 6b of the EU Biodiversity Strategy). The Communication includes a GI Strategy that focuses on four main elements, namely:

1. to promote the concept in main policy fields of the EU;
2. to expand information and access to related knowledge;
3. to extend and improve financing of such projects; and
4. to aid EU level project planning and implementation.

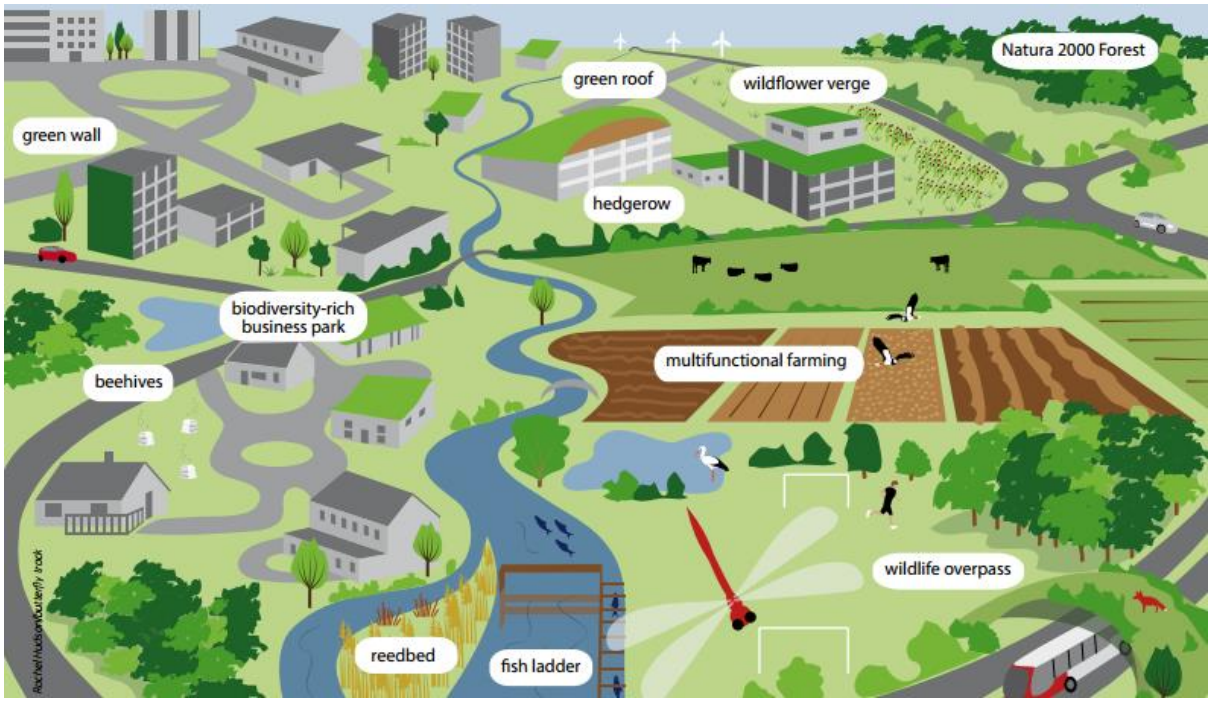
To underline its importance for the EU, the Resource Efficiency Roadmap (EC, 2011b) clearly identified GI as an important step towards protecting the EU's natural capital. Target 2 of the EU Biodiversity Strategy is one of the thematic priorities in the 7th Environmental Action Programme to 2020 'Living well, within the limits of our planet'(EPC, 2013). The latter underlines the importance of GI for socio-economic and environmental targets describing it as 'a tool for providing ecological, economic and social benefits through natural solutions, incorporating green spaces, aquatic ecosystems and other physical features in terrestrial and marine areas'. Also according to the 'Territorial Agenda of the European Union 2020', working with nature and in harmony with the local landscape to deliver essential goods and services through GI projects, using a 'place-based' approach, is cost-effective and preserves the physical features and identity of the locality (MRSPTD, 2011).

2 Green infrastructure serving many goals

2.1 What is green infrastructure (GI)

Green infrastructure is a spatial concept that goes beyond the establishment of ecological networks (Figure 2.1). It complements ecological networks and systems of protected areas by adding more prominently the multiple functions that a given piece of land has. It also focuses more strongly on the ecosystem services to the benefit of human well-being, and adds environmental features in both urban and rural landscapes. The European Commission's GI Strategy proposes a definition for use in Europe: 'a strategically planned network of natural and semi-natural areas with other environmental features designed and managed to deliver a wide range of ecosystem services. It incorporates green spaces (or blue if aquatic ecosystems are concerned) and other physical features in terrestrial (including coastal) and marine areas. On land, GI is present in rural and urban settings' (EC, 2013c).

Figure 2.1 Potential components of GI within a landscape



Source: EC, 2013a

The ultimate aim of GI is to contribute to the development of a greener and more sustainable economy by investing in ecosystem-based approaches delivering multiple benefits in addition to technical solutions, and mitigating adverse effects of transport and energy infrastructure (EEA, 2011a). The concept of GI serves a wide range of functions (UWE Science Communication Unit, 2012):

- protecting ecosystems state and biodiversity,
- improving ecosystem functioning and promoting ecosystem services,
- promoting societal well-being and health,
- supporting the development of a green economy, and sustainable land and water management.

By providing a wider range of functions, GI is expected to contribute to the implementation of numerous policies by offering nature-based solutions. These are often more sustainable and more cost-efficient than their conventional 'grey infrastructure' alternatives and provide opportunities for multiple services from the same piece of land and/or water. For example, construction of an urban wetland system, in Numella, Finland — for improving the water quality, flood control and combating erosion — equalled to one fifth of the cost that would have incurred if the artificial pipes and drainage system would have been placed instead. This is excluding all the additional benefits such as increase in biodiversity, and opportunities for recreation and education (Salminen et al., 2013).

An equivalent idea is to use nature-based flood defences which make use of the natural dynamics in the coastal and shore protection. Such an approach, in comparison with the more traditional engineering solutions, is based on multifunctional use of space: it may add natural value, increase the attractiveness of the landscape, serve as carbon sink, be more sustainable, be adaptive, and reduce cost (e.g. Sigma Plan II project described in Box 4.1) (De Vriend and Van Koningsveld, 2012).

More examples where GI solutions showed to be more cost-efficient are described in Box 4.1 showing some examples of GI integration in different sectors.

In an urban environment GI could play a central role in flood attenuation and building design through provision of sustainable drainage schemes and green (living) roofs. To do so successfully, GI will need to reach into every neighbourhood and be designed to complement the natural hydrology and drainage of the location and the wider region, incorporating flood plains and river corridors (TCPA and The Wildlife Trusts, 2012).

Because of its broad scope in potential service delivery GI can be made up of a wide range of different environmental features which can operate at different scales. These can range from small linear features such as hedgerows or fish ladders or green roofs to entire functional ecosystems, such as virgin floodplain forests, peatlands or free-flowing rivers. Each one of these elements can contribute to GI in urban, peri-urban and rural areas, inside and outside protected areas (EC, 2013a).

GI features can be grouped into three broad categories of scales (EEA, 2011a):

- local, neighbourhood and village scale,
- town, city and district scale,
- city-region, regional and national scale.

Concrete examples of GI features at different scales are given in Table 2.1.

Table 2.1 Potential features that make up green (and blue) infrastructure grouped into three scale groups

Local scale	Regional and national scale	EU level	Descriptor
Natural and semi-natural ecosystems e.g. pastures, woodland, forest (no intensive plantations), ponds, bogs, rivers and floodplains, coastal wetlands, lagoons, beaches, marine habitats	Extensive agricultural and forest landscapes, large marsh and bog areas, rivers and floodplains, shorelines/coastal zones	Freshwater systems, major river basins, mountain ranges, regional sea basins	Core areas – outside protected areas

Local scale	Regional and national scale	EU level	Descriptor
Local nature reserves, water protection areas, landscape protection areas, Natura 2000 sites	Regional and National Parks and wilderness zones (includes Natura 2000 sites)	Ecological networks with cross-border areas, incl. Natura 2000 network	Core areas/protected areas
Restored areas which were before fragmented or degraded natural areas, brownfield land or disused quarries, transitional ecosystems due to land abandonment or regeneration processes	Restored ecosystem types	Restored landscape systems covering a substantial part of agricultural/forestry areas and industrialised sites, including cross-border areas	Restoration zones
High nature value farmland and multi-use forests (such as watershed forests), protection forests (against avalanches, mudslides, stonewall, forest fires), natural buffers such as protection shorelines with barriers, beaches and salt marshes	Extensive agricultural landscapes, sustainable forest management on regional and national level, functional riparian systems	Transboundary landscape features on river basin or mountain range level, sustainable coastal and marine management zones related to the respective sea basin	Sustainable use zones
Street trees and avenues, city forests/woodlands, high-quality green public spaces and business parks/premises, green roofs and vertical gardens, allotments and orchards, storm ponds and sustainable urban drainage systems, city reserves incl. Natura 2000	Greenways, green belts, metropolitan park systems	Metropolitan areas with substantial share of high quality green areas in Europe, including coherent approaches in cross-border urban zones	Green urban and peri-urban areas
Hedgerows, stone walls, small woodlands, ponds, wildlife strips, riparian river vegetation, transitional ecosystems between cropland, grassland and forests	Multi-functional, sustainably managed agricultural landscapes, riparian systems	Supra-regional corridors, substantial share of structure-rich agricultural, forestry or natural landscapes	Natural connectivity features
Eco-ducts, green bridges; animal tunnels (e.g. for amphibians), fish passes, road verges, ecological powerline corridor management	De-fragmented landscapes, improved areas along transport and energy networks, migration corridors, river continuum	European-wide or transnational defragmentation actions	Artificial connectivity features

Source: EC, 2013d

2.2 Multiple benefits of green infrastructure

The European Commission (EC, 2013a) has set up GI to promote innovative solutions to land use and spatial or territorial planning by combining often competing land management issues — e.g. demands and pressures, such as housing, industry, transport, energy, agriculture, nature conservation, recreation and aesthetics — in a spatially coherent manner. At the same time the potential for multiple co-benefits and win-win solutions may be enhanced (Table 2.2). Investments in GI could create both high- and low-skilled jobs, such as in planning, engineering and building its elements as well as in restoring and maintaining urban and rural ecosystems.

Table 2.2 Benefits provided by GI

Environmental benefits	• Provision of clean water • Removal of pollutants from air and water • Pollination enhancement • Protection against soil erosion • Rainwater retention • Increased pest control • Improvement of land quality • Mitigation of land take and soil sealing
Social benefits	• Better health and human well-being • Creation of jobs • Diversification of local economy • More attractive, greener cities • Higher property values and local distinctiveness • More integrated transport and energy solutions • Enhanced tourism and recreation opportunities
Climate change adaptation and mitigation benefits	• Flood alleviation • Strengthening ecosystems resilience • Carbon storage and sequestration • Mitigation of urban heat island effects • Disaster prevention (e.g. storms, forest fires, landslides)
Biodiversity benefits	• Improved habitats for wildlife • Ecological corridors • Landscape permeability

Source: EC, 2013a

3 Green infrastructure benefiting biodiversity

Landscape fragmentation and habitat loss are among the main causes of loss of biodiversity and ecosystem services at the European level (EEA, 2011b). Habitat loss, degradation and fragmentation are by far the biggest drivers of terrestrial biodiversity loss at EU level over the past 50 years (EC, 2010b). According to the Millennium Ecosystem Assessment, Europe's territory is more fragmented than any other continent (WRI, 2005). In the EU some 30 % of land area is moderately to highly fragmented (EC, 2011a).

Landscape fragmentation is the result of transforming large habitat patches into smaller, more isolated fragments of habitat. This process is most evident in urbanised or otherwise intensively used regions, where fragmentation is the product of the linkage of built-up areas via linear infrastructure, such as roads and railroads. Over the last 50 years, the transport networks throughout the European continent have become increasingly dense and the urban areas have greatly expanded (EEA, 2011b). In addition, traditional land use practices have been replaced by more intensive, mechanised and industrial-scale activities, especially in the agricultural and forestry sectors. This has weakened the resilience of once biodiversity-rich ecosystems.

Whereas land use change has direct impacts on biodiversity through habitat loss, fragmentation causes more indirect effects through loss of connectivity between populations of species. This can have an impact on population survival. Fragmentation has significant effects on biodiversity and ecosystem services. Increasing fragmentation might seriously hinder species movement, as well as affect ecosystem services such as water-related services and erosion prevention. Other consequences of fragmentation may impact food and timber production or reduced quality of agricultural products along roads. Also cultural services (e.g. landscape amenity) can be considerably influenced (EEA, 2011b).

It is important to keep in mind that there will need to be a balance between maximizing the benefits GI can provide to biodiversity, which clearly are numerous, and other benefits GI could deliver in the form of various ecosystem services and benefits to people which will not necessarily deliver benefits to biodiversity. In some cases, clearly choices will have to be made. To illustrate this, enhanced connectivity by establishing migration corridors between Natura 2000 sites, while benefiting biodiversity, might not maximise the delivery of other ecosystem services. Also a management regime of a Natura 2000 site aiming at achieving Favourable Conservation Status – maximising biodiversity benefits – might involve some limitations in the use of the area for recreational purposes thus limiting benefits from cultural services.

Natura 2000, with more than 27 000 terrestrial sites covering some 18 % of the EU territory and almost 3 000 marine sites covering some 4 % of the EU marine area (EC, 2014b), and the EU policy for developing it (i.e. Habitats and Birds directives), is a main vehicle for GI implementation. It not only acts as an important reservoir for biodiversity and healthy ecosystems, which can be drawn upon to revitalise degraded environments across the broader landscape but also delivers many ecosystem services to society. In forming the hubs of a European GI, Natura 2000 sites provide a strategic focus for protection of European biodiversity, improving our natural environment and enhancing the quality of our lives. At the same time, implementing a GI beyond protected areas will help to strengthen the coherence of the Natura 2000 network by making the core areas more resilient, and by providing buffers against impacts on the sites (EC, 2013a).

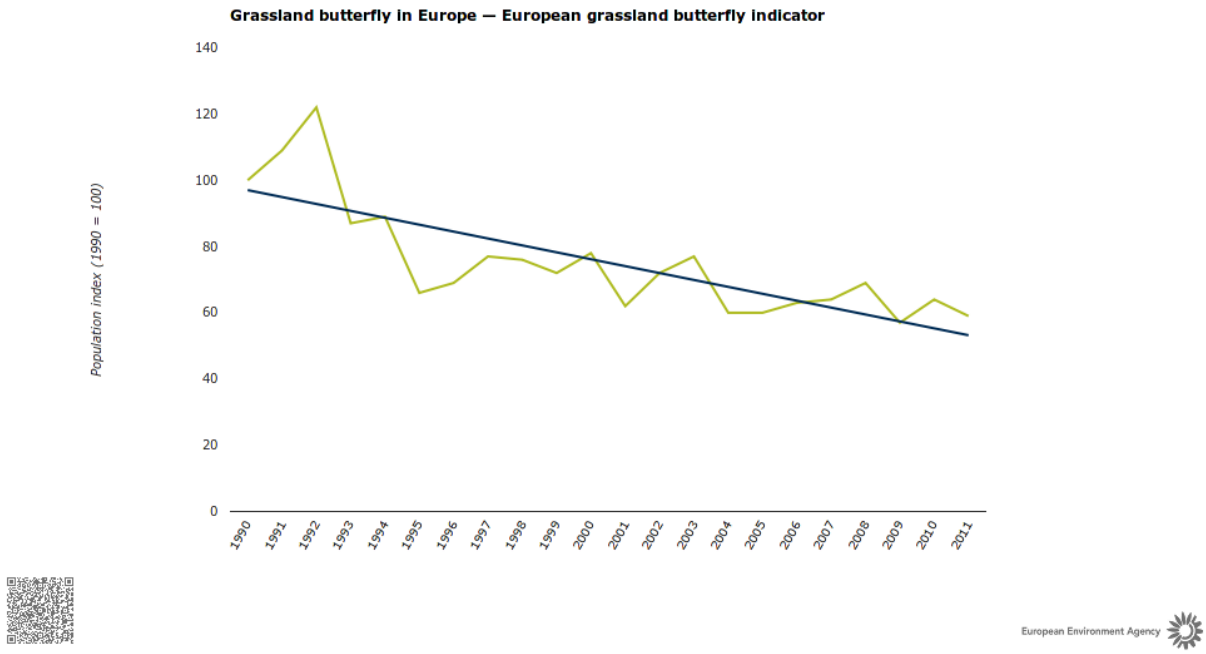
Despite its economic benefits (e.g. Natura 2000 provides approximately 8 million full time jobs and indirectly an additional 4 million (Bio intelligence, 2011)), more needs to be done still to improve the ecological status of the network. A healthier Natura 2000 network will also lead to a higher level of benefits provision to biodiversity, society and the economy, as well as be more resilient to environmental pressures including climate change (EC, 2013e).

Semi-natural features within agricultural lands are important elements of GI. The species richness of various groups increases with the area of semi-natural habitats in the landscape (Billeter et al., 2008). Studies suggest that to halt the loss of biodiversity within the agricultural landscapes, it is important to preserve and, if possible, increase the area of semi-natural habitat. Further action in this direction is needed as according to the most recent data submitted by the EU Member States under the Habitats Directive Article 17 reporting([1]) (reporting cycle 2007-2012) 84 % of the agricultural habitat types([2]) were reported as having an unfavourable conservation status. Populations of grassland butterflies in Europe declined by almost 50 % between 1990 and 2011, indicating a dramatic loss of grassland biodiversity, one of the most important agricultural habitats in Europe (Figure 3.1) (Van Swaay, C.A.M. et al., 2012).

[1] Article 17 requires Member States to report every six years about the progress made with the implementation of the Habitats Directive. As the main focus of the directive is on maintaining and/or restoring a favourable conservation status for habitat types & species of community interest, monitoring & reporting under the directive is focusing on that.

[2] Habitat types identified as agricultural according to: Halada, Ľ., Evans, D., Romaõ, C. Petersen, J.E., 2011: Which habitats of European Importance depend on agricultural practices? – Biodiversity and Conservation 20: 2365-2378 DOI: 10.1007/s10531-011-9989-z.

Figure 3.1 European grassland butterfly indicator



Source: Van Swaay, C.A.M. et al., 2012

Forest ecosystems provide ecosystem services on which both rural and urban communities depend, and host an enormous variety of biodiversity. Therefore, forest ecosystems are considered to be a core part of the EU's GI and protection efforts are required to maintain, enhance and restore forest ecosystems' resilience and multi-functionality (EC, 2013b). When more than 15 000 ha of new forest habitat (mostly beech and oak) was created on the agricultural land in Weser-Ems in Lower Saxony in Germany, as part of an effort to protect the supply of drinking water, this has had a positive influence on the landscape character and a significant influence on improving the water quality (Torre-Marín et al., 2012). According to the latest Article 17 reports from the Member States 80 % of conservation status assessments of woodland and forest habitats are unfavourable. Therefore immediate action on conservation of forest habitats is needed at the European level.

Wetlands, another key element of GI, are important for the wider functioning of ecosystems and protection of biodiversity. Wetlands provide a number of regulating services and they contribute to solving important environmental problems like water quality, eutrophication, water quantity management (flooding and drought), carbon sequestration and climate regulation (De Nocker, 2011).

The GI restoration project of Comana Wetland Natura 2000 site, in Romanian Giurgiu County, resulted in numerous benefits for biodiversity. The site is part of the Lower Danube Green Corridor, which is a network of protected Natura 2000 sites linking four countries: Romania, Bulgaria, Moldova and Ukraine. Because of the water management measures taken before 1990, the area was transformed from a wetland to a predominantly terrestrial environment. The objective of the project was to restore the wetland habitats. This resulted in numerous benefits for biodiversity (i.e. increased diversity and abundance of fish species and their invertebrate prey, improved quality of habitats and species richness in general) (Lucius et al., 2011).

According to the most recent Article 17 reports by the Member States, as much as 85 % of the assessments of wetland habitats were reported as having an unfavourable conservation status.

Migration corridors, often as a part of the broader system — *Ecological networks* — as key elements of GI, provide multiple benefits for biodiversity. They are key to the coherence of Natura 2000 as a network and improve its effectiveness in conserving biodiversity. Migration corridors enable linkages between isolated patches of habitats and therefore increase the viability of species linked to them (Bennett and Mulongoy, 2006). Migration corridors are believed to facilitate the movement of species across fragmented landscapes and mitigate the adverse effects of man-caused fragmentation on population viability and biodiversity (Paerson and Dawson, 2005). To some extent they will also help mitigate the effects of climate change (e.g. by facilitating long-distance dispersal) which will further exacerbate the problem of fragmentation by causing increasing gaps in the distribution range of species (Opdam and Wascher, 2004). Corridors can vary enormously in scale: from a tunnel to allow amphibians to pass under a road to intercontinental flyways for migrating birds. The term corridor is often used to describe many different kinds of measures, including landscape linkages (both linear and non-linear), recreational routes (also known as greenways) and entire ecological networks (Bennett et al., 2006).

The Alpine-Carpathian corridor, for example, supports the aims of the Alpine Convention and constitutes, besides the Danube and the Green Belt along the former 'iron curtain', a major migration route of European importance (Naumann et al., 2011). This three year cross-border and cross-sectoral project was implemented under the European Territorial Cooperation Objective of the European Regional Development Fund (ERDF). The goals of the project were to mitigate the fragmentation effects of motorways, by building 'green bridges' over highways at key points, as well as to create suitable habitats to reconnect existing stepping stones, which are needed as resting and feeding places for migrating animals. To guarantee the effectiveness of these measures, the ecological network should be integrated into spatial planning and environmental impact assessments (Lucius et al., 2011).

The ecological networks approach, however, has for long focused on the conservation of biodiversity. More recently, with the increased attention to ecosystem services and the benefits they provide to human well-being, other aspects have entered the policy development. The concept of GI captures all these different aspects, but without losing the sight of benefits for biodiversity.

4 Implementation and future actions

4.1 Promoting green infrastructure in the main policy areas / sectors

According to the EU GI Strategy, GI should and can be promoted and implemented across the main policy areas within the context of existing legislation, policy instruments and funding mechanisms (EC, 2013c). The new GI strategy advocates the full integration of GI into these policies so that it becomes a standard component of territorial development across the EU (EC, 2013a).

Green infrastructure is also recognised as contributing to regional policy and sustainable growth in Europe (Doranova et al., 2012). Systematically including GI considerations in the planning and decision-making process will help reduce the loss of ecosystem services associated with future land take, and can help improve and restore soil and ecosystem functions (EEA, 2014).

Policy areas that could potentially benefit the most from implementing GI include regional and rural development, climate change, disaster risk management, agriculture, forestry and the environment (EC, 2013a). Other policies benefiting from GI implementation are water and floods policy, soil, marine and coastal policies. Transport and energy policies could also gain from the mitigating role GI delivers, but they would need to be considerably more proactive with integration efforts in the mid- and long-term perspective (EEA, 2011a).

Box 4.1 Examples of GI integration in different sectors

GI and forestry

Approximately 47 % (39 600 km^2) of the Austrian land territory is covered by forest, predominantly still natural. They are largely privately owned and managed for centuries in smaller plots and have remained relatively semi-natural. Approximately 7 800 km^2 (20 %) of these forests are classified as 'Protection Forests' (*Bann- und Schutzwälder*) by the Austrian Forest Act. The primary objective of the Act is not the conservation of biodiversity, which is a secondary consideration, but the protection of forests which play an important role regarding the benefits provided to human well-being, particularly with respect to their role in natural hazards control, their value for recreation and tourism and general socio-economic functions. Nonetheless, the status 'Protection Forest' limits the use of forests for timber production or sets requirements for the application of specific silvicultural measures (including e.g. reduced intervention and harvesting). While a total of €275 million was invested in 2010, the Ministry of Environment estimates that without Protection Forests an additional €600 million would need to be invested in technical solutions every year to achieve the same level of protection against natural hazards.

GI and water management

The Sigma Plan II refers to a long-term strategy and list of projects to manage flood protection and nature restoration of the Scheldt estuary in Belgium. It includes a series of projects in the short and longer term (2006–2030) to restore flood plains, estuarine nature and wetlands along the Scheldt and its tributaries. It is part of the transnational (Belgium-Netherlands) long-term vision for the Scheldt estuary in 2030. The project will lead to 5 000 ha of extra natural areas, which is a very significant contribution to the natural areas required for ecological objectives and to ensure adequate protection and restoration of estuarine processes necessary for protection of habitats and species. The costs of the project up to 2030 are significant (€500 million) but the expected flood protection benefits (€740 million) guarantee a positive, net economic effect.

GI and urban planning

Basel City is interested in green roofs as an energy-saving measure for buildings. An electricity tax generated funds (5 % of all customers' energy bills) and an Energy Saving Fund was then used to fund energy-saving campaigns and measures. The municipality was quick to involve a variety of stakeholders, such as business associations and environmental organisations, in developing an incentive programme. Green roofs were funded for a two-year period in the mid-1990s to stimulate interest and awareness. A second programme was initiated in 2005–2006, based on the successes of the first, on the new building regulations and on the results of an investigation into the benefits of green roofs for biodiversity, especially to protect endangered invertebrate species. This initiative focuses on climate change adaptation. The cost-benefit ratio of this initiative appears to be positive.

Source: Case studies from Mazza et al. (2011)

The European Commission is continuously making available technical guidance documents on how to integrate GI into the implementation of the main policies and their associated funding mechanisms. Several such documents are already available on the Commission's website 'Background on Green Infrastructure' (EC, 2015a) and further documents are still being prepared (e.g. on the links between agriculture and climate change adaptation).

In their actions of promoting GI across the key sectors the European Commission is supported by a number of environmental NGOs. They are implementing various actions (e.g. organising workshops and conferences, preparing guidance documents) aimed at raising awareness among the stakeholders and providing guidance on how to put GI into practice. Based on the stakeholder discussions from a

number of such NGO-organised events some of the key success factors for GI projects include (CEEweb for Biodiversity and ECNC, 2013):

- emphasis on holistic solutions - not only on environmental benefits, but also on socio-economic aspects and advantages (e.g. growth and jobs);
- wide involvement of different stakeholders at all stages;
- utilization of different funds;
- good understanding of the needs for and benefits of GI;
- GI inclusion into spatial planning;
- citizens' involvement in project design and implementation;
- legal harmonization between different levels of governance;
- exchange of experience and applying lessons-learnt from other projects;
- networking with implementers of similar projects;
- measuring and depicting the multiple benefits of the project;
- good communication of benefits of GI solutions for gaining support.

Also other specific actions in support of Target 2 of the EU Biodiversity Strategy to 2020 contribute directly to the implementation of GI in and beyond Natura 2000. This is the case for:

- the restoration of degraded ecosystems in the 'wider countryside' (i.e. outside of Natura 2000), in particular to combat fragmentation, for which a restoration prioritisation framework has been set up — a tool to help and support the Member States and the European Commission in guiding the choices for the delivery of the 15 % restoration target (Lammerant et al., 2014).

- the work on No Net Loss (NNL). In order to achieve the EU's headline biodiversity target, it appears necessary to take steps to achieve both NNL of biodiversity and NNL of ecosystem services. In addition, the overall NNL objective should apply to all species and habitats that require conservation. According to the Council's conclusions and the European Parliament's Resolution, NNL measures should complement existing measures and therefore apply to all EU habitats and species, including those not covered by EU legislation (Tucker et al., 2013).

4.2 Improving information, strengthening the knowledge base and promoting innovation

The understanding of the technical issues associated with deploying GI has developed considerably in recent years. The majority of this information is available via the dedicated website on GI maintained by the European Commission (EC, 2015b). Nevertheless, more research is needed to improve the understanding of the links between biodiversity, the condition of the ecosystem and its capacity to deliver ecosystem services. Also, a minimum level of consistency is needed in relation to the data used to inform the decisions regarding GI projects, particularly for projects supported by EU funds. Under the GI strategy, the European Commission is working to ensure the most effective use of data from current and planned actions and is providing financial support for programmes such as Horizon 2020, that tackle this knowledge gap (EC, 2013a).

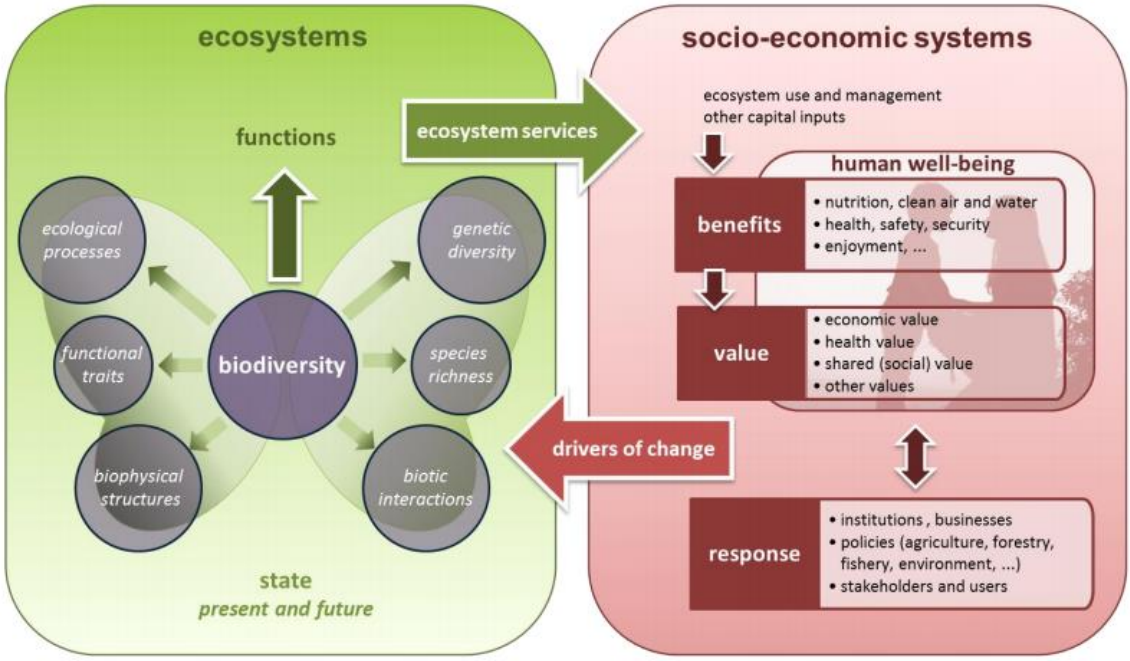
To facilitate information exchange the European Commission has included the 'Green Infrastructure Library' in BISE – the Biodiversity Information System for Europe (EC and EEA, 2014).The GI Library aims to share best practice and enrich common knowledge on GI approaches.

It is equally important to continue to support the development of the innovative technology and processes for GI, and to ensure specialists acquire the necessary skills and competences to apply them. Further specialised training in GI technology will be essential in the medium term (EC, 2013a).

A key component in developing GI in Europe is the possibility to map and assess ecosystems and the services they deliver. The initiative on Mapping and assessing ecosystems and their services (MAES) accommodates for this need and ensures coordination of approaches across Europe. Action 5([3]) of the EU Biodiversity Strategy to 2020 and the work undertaken by MAES should support the maintenance and restoration of ecosystems and their services, and should have strong linkages to the work being undertaken on mapping and assessment in relation to the EU's agenda on territorial cohesion (spatial planning and territorial development) (EC, 2014a); Maes et al., 2013).

A first outcome of the MAES process is the development of a coherent analytical framework (Figure 4.1) to be applied by the EU and its Member States in order to ensure consistent approaches are used. It is therefore framed by a broad set of key policy questions. It is structured around a conceptual framework that links human societies and their well-being with the environment (Maes et al., 2013).

Figure 4.1 MAES Conceptual framework for EU wide ecosystem assessment



Source: Maes et al., 2013

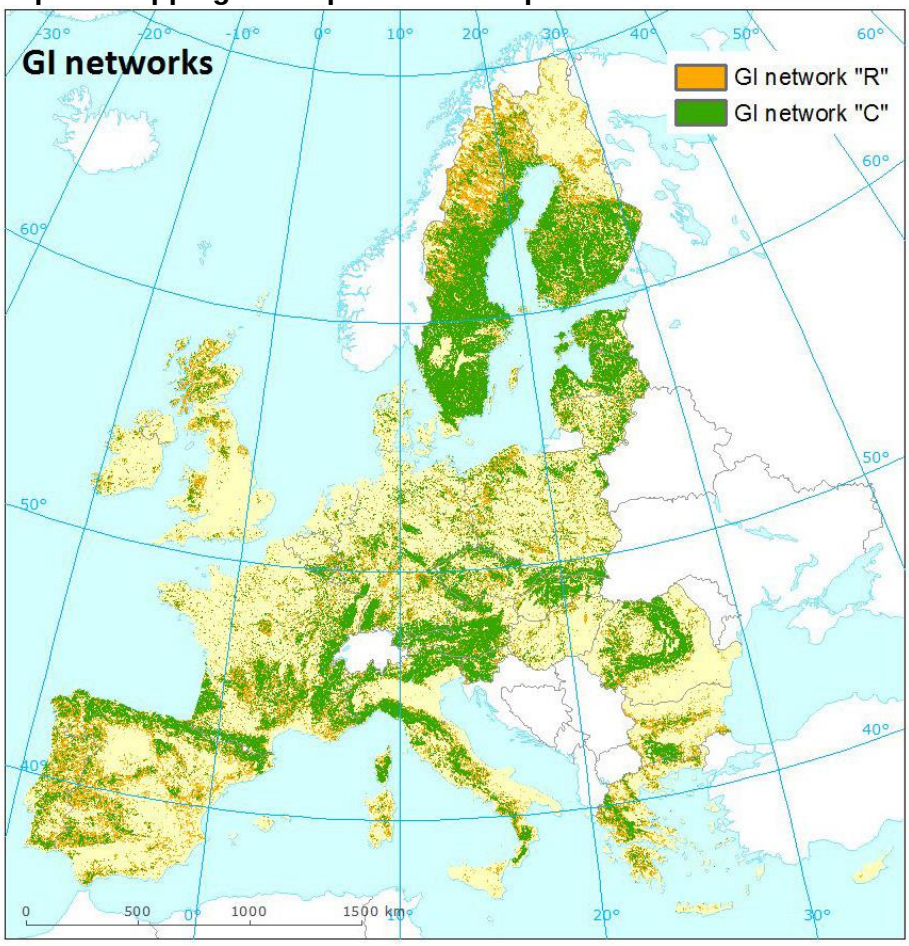
The EEA (2014b) proposed, developed and tested a theoretical framework for the identification and mapping of GI elements at landscape level, taking into consideration their multifunctional character and the potential of ecosystem services' supply. The study focuses on GI support for the provision of habitat to biota, the connectivity of habitats and their protection, and the delivery of ecosystem services (EEA, 2014)

[3] Action 5 calls Member States to map and assess the state of ecosystems and their services in their national territory with the assistance of the European Commission.

The identified and mapped GI elements are integrated into two GI networks, as aggregated and represented in Map 4.1:

- GI conservation network ('C') comprises areas providing key ecological functions, both for wildlife and for human well-being. Conservation must be given priority in order to maintain essential connectivity of natural and semi-natural habitats.
- GI restoration network ('R') still provides important ecological functions, but its capacity could be improved with some protection or restoration ('R'). The upgrade of these GI elements to the GI network 'C' would increase its ecological and social resilience.

Map 4.1 Mapping of the potential European GI networks



Source: EEA, 2014

4.3 Improving access to finance

The intention of the EU is for its main policies and their accompanying financial instruments to be vital for mobilising the potential of EU regions and cities to invest in GI. Interventions financed by the EU should support synergies and co-benefits between economy and environment (EC, 2013a).

The European Commission is in dialogue with Member States about their Operational Programmes and exploring the opportunities on how these could provide more opportunities for financing the GI projects.

The private sector also has an important role to play in financing GI. Projects on GI are, however, complex and are often perceived as risk by investors, particularly in the early stages of development.

Therefore, the European Commission and the European Investment Bank are establishing a financing facility to support natural capital-related investments, including GI projects (EC, 2013c).

4.4 EU-level green infrastructure projects

An important element of the new GI strategy is to explore developing a trans-European Green Infrastructure (TEN-G) initiative, similar to those already in place for large-scale EU transport (TEN-T) and energy (TEN-E) networks. Developing a TEN-G would not only have significant benefits for securing the resilience and vitality of some of Europe's most precious ecosystems but could act as an important flagship for promoting GI at national, regional and local levels and boosting the importance of GI in policy, planning and financing decisions. Member States and regions can be supported by the ERDF and through European territorial cooperation programmes to develop GI in a cross-border/transnational context. (EC, 2013c).

The potential development of the TEN-G can build on previous efforts in this field, although largely focused on the function of biodiversity conservation. Apart from Natura 2000 key initiatives include the European Green Belt which provides a linear GI over the entire length of what once was the iron curtain (Marschall et al., 2012), and the PEEN (Bonnin et al., 2007; Jongman et al., 2011), which was mapped in the framework of the Pan-European Biological and Landscape Diversity Strategy.

5 References

Bennett, G. and Mulongoy, K. J., 2006, *Review of Experience with Ecological Networks, Corridors and Buffer Zones*, 23, Secretariat of the Convention on Biological Diversity, Montreal.

Billeter, R., Liira, J., Bailey, D., Bugter, R., Arens, P., Augenstein, I., Aviron, S., Baudry, J., Bukacek, R., Burel, F., Cerny, M., De Blust, G., De Cock, R., Diekötter, T., Dietz, H., Dirksen, J., Dormann, C., Durka, W., Frenzel, M. et al., 2008, 'Indicators for biodiversity in agricultural landscapes: a pan-European study', *Journal of Applied Ecology* 45(1), pp. 141–150.

Bio intelligence, 2011, *Estimating the economic value of the benefits provided by the tourism/recreation and Employment supported by Natura 2000*, Final Report, 07.0307/2010/581498/SER/B.3, Bio intelligence service.

Bonnin, M., Bruszik, A., Delbaere, B., Lethier, H., Richard, D., Rientjes, S., van Uden, G. and Terry, A., 2007, *The Pan-European Ecological Network--taking stock*, Council of Europe, Strasbourg.

CEEweb for Biodiversity and ECNC, 2013, *Enriching our society through natural solutions: Why and how to make Green Infrastructure projects a sustainable answer for ecological, social and economic problems?*, CEEweb for Biodiversity, Budapest, Hungary.

CBD, 2010, 'TARGET 11 - Technical Rationale extended (provided in document COP/10/INF/12/Rev.1)', *Convention on Biological Diversity* (http://www.cbd.int/sp/targets/rationale/target-11/) accessed July 23, 2014.

Doranova, A., Griniece, E., Miedzinski, M. and Reid, A., 2012, *Connecting Smart and Sustainable Growth through Smart Specialisation - A practical guide for ERDF Managing Authorities*, European Commission.

EC, 2010a, Communication from the Commission 'EUROPE 2020 - A strategy for smart, sustainable and inclusive growth', COM(2010) 2020 of 3 March 2010.

EC, 2010b, *LIFE building up Europe's green infrastructure: Addressing connectivity and enhancing ecosystem functions*, Publications Office Of the European Union, Luxembourg.

EC, 2011a, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee Of The Regions 'Our life insurance, our natural capital: an EU biodiversity strategy to 2020', COM(2011) 244 final of 3 May 2011

EC, 2011b, Roadmap to a Resource Efficient Europe, COM(2011) 571 final of 20 September 2011

EC, 2013a, *Building a Green Infrastructure for Europe*, European Commission.

EC, 2013b, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee Of The Regions 'A new EU Forest Strategy: for forests and the forest-based sector', COM(2013) 659 final of 20 September 2013

EC, 2013c, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee Of The Regions 'Green Infrastructure (GI) — Enhancing Europe's Natural Capital', COM(2013) 249 final of 6 May 2013

EC, 2013d, *Physical features of Green Infrastructure in relation to scale and function*, European Commission.

EC, 2013e, *The Economic benefits of the Natura 2000 Network*, Synthesis Report, 07.0307/2010/581178/SER/B3, European Commission.

EC, 2014a, *Mapping and Assessment of Ecosystems and their Services: Indicators for ecosystem assessments under Action 5 of the EU Biodiversity Strategy to 2020*, 2nd Report, European Commission.

EC, 2014b, 'Natura 2000 barometer', *Nature and Biodiversity Newsletter Natura 2000* Number 36(July 2014) (http://ec.europa.eu/environment/nature/info/pubs/docs/nat2000newsl/nat36_en.pdf).

EC, 2015a, *Background on Green Infrastructure*, (http://ec.europa.eu/environment/nature/ecosystems/background.htm) accessed February 6, 2015.

EC, 2015b, *Green Infrastructure*, (http://ec.europa.eu/environment/nature/ecosystems/index_en.htm) accessed February 6, 2015.

EC and EEA, 2014, *BISE – the Biodiversity Information System for Europe*, (http://biodiversity.europa.eu/) accessed February 6, 2015.

EEA, 2011a, *Green infrastructure and territorial cohesion - The concept of green infrastructure and its integration into policies using monitoring systems*, EEA Technical Report, No 18/2011, European Environment Agency.

EEA, 2011b, *Landscape fragmentation in Europe, Joint EEA-FOEN report*, EEA Technical Report, No 2/2011, European Environment Agency.

EEA, 2014, *Spatial analysis of green infrastructure in Europe*, EEA Technical Report, No 2/2014, European Environment Agency.

EPC, 2013, General Union Environment Action Programme to 2020 'Living well, within the limits of our planet', DECISION No 1386/2013/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 20 November 2013

Ilke Marschall, Matthias Gather and Marion Müller, 2012, *The Green Belt as a European Ecological Network – strengths and gaps. Proceedings of the 1st GreenNet Conference, 31st of January 2012, Erfurt*,

Jongman, R. H. G., Bouwma, I. M., Griffioen, A., Jones-Walters, L. and Doorn, A. M. V., 2011, 'The Pan European Ecological Network: PEEN', *Landscape Ecology* 26(3), pp. 311–326.

Lammerant, J., Peters, R., Snethlage, M., Delbaere, B., Dickie, I. and Whiteley, G., 2014, *Priorities for the restoration of ecosystems' and their services in the EU*, Arcadis (in cooperation with ECNC and eftec).

Lucius, I., Caratas, R. D., Caratas, D., Mey, F., Steinert, J. and Torkler, P., 2011, *Green Infrastructure Sustainable Investments for the Benefit of Both People and Nature*, SURF-nature project, Giurgiu County Council, Romania.

Maes, J., Teller, A., Erhard, M., Liquete, C., Braat, L., Berry, P., Egoh, P., Puydarrieux, P., Fiorina, C., Santos, F., Paraccini, M. L., Keune, H., Wittmer, H., Hauck, J., Fiala, I., Verburg, P. H., Condé, S., Schägner, J. P., San Miguel, L. et al., 2013, *Mapping and assessment of ecosystems and their services: an analytical framework for ecosystem assessments under action 5 of the EU biodiversity strategy to 2020: discussion paper - final*, Publications Office Of the European Union, Luxembourg.

Mazza, L., Bennett, G., De Nocker, L., Gantioler, S., Losarcos, L., Margerison, C., Kaphengst, T., McConville, A., Rayment, M., ten Brink, P., Tucker, G. and van Diggelen, R., 2011, *Green Infrastructure Implementation and Efficiency*, Final Report, Institute for European Environmental Policy.

MRSPTD, 2011, *Territorial Agenda of the European Union2020 - Towards an Inclusive, Smart and Sustainable Europe of Diverse Regions*, Ministers responsible for Spatial Planning and Territorial Development, Gödöllő, Hungary.

Naumann, S., Davis, M., Pieterse, M. and Rayment, M., 2011, *Design, implementation and cost elements of Green Infrastructure projects*, Final Report, 070307/2010/577182/ETU/F.1, Ecologic institute and GHK Consulting.

De Nocker, L., 2011, *Green Infrastructure In-Depth Case Analysis Theme 4: Freshwater and Wetlands Management and Restoration*, Institute for European Environmental Policy.

Opdam, P. and Wascher, D., 2004, 'Climate change meets habitat fragmentation: linking landscape and biogeographical scale levels in research and conservation', *Biological Conservation* 117(3), pp. 285–297.

Paerson, R. G. and Dawson, T. P., 2005, 'Long distance plant dispersal and habitat fragmentation: identifying conservation targets for spatial landscape planning under climate change', *Biological Conservation* 123(3), pp. 389–401.

Salminen, O., Ahponen, H., Valkama, P., Vessman, T., Rantakokko, K., Vaahtera, E., Taylor, A., Vasander, H. and Nikinmaa, E., 2013, 'Benefits of green infrastructure - socio-economic importance of constructed urban wetlands (Nummela, Finland)', in: *Kettunen et al. Socio-economic importance of ecosystem services in the Nordic Countries - Scoping assessment in the context of The Economics of Ecosystems and Biodiversity (TEEB). Nordic Council of Ministers, Copenhagen.*,

TCPA and The Wildlife Trusts, 2012, *Planning for a Healthy Environment – Good Practice Guidance for Green Infrastructure and Biodiversity*, Town & Country Planning Association and The Wildlife Trusts, London and Nottinghamshire.

Torre-Marín, A., Snethlage, M. and Delbaere, B., 2012, *Nature works for regions*, ECNC, Tilburg, the Netherlands.

Tucker, G., Allen, B., Conway, M., Dickie, I., Hart, K., Rayment, M., Schulp, C. and van Teeffelen, A., 2013, *Policy Options for an EU No Net Loss Initiative. Report to the European Commission.*, Final Report, Institute for European Environmental Policy.

UWE Science Communication Unit, 2012, *The multifunctionality of Green Infrastructure*, University of the West of England for European Commission DG Environment.

Van Swaay, C.A.M., Van Strien, A.J., Harpke, A. and Fontaine, B., Stefanescu, C., Roy, D., Maes, D., Kühn, E., Õunap, E., Regan, E., Švitra, G., Heliölä, J., Settele, J., Pettersson, L., Titeux, N., Cornish, N., Leopold, P., Julliard, R., Verovnik, R., Popov, S., Collins, S., Goloshchapova, S., Roth, T., Brereton, T. & Warren, M.S., 2012, *The European Butterfly Indicator for Grassland species 1990-2011*, Report VS2012.019, De Vlinderstichting, Wageningen.

De Vriend, H. J. and Van Koningsveld, M., 2012, *Building with Nature: Thinking, acting and interacting differently*, EcoShape, Dordrecht, the Netherlands.

WRI, 2005, *Ecosystems and human well-being: biodiversity synthesis*, World Resources Institute, Washington, DC.